IN THE CLAIMS

1. (currently amended) A method for determining at least one of motion and location parameters of a railroad locomotive, with the locomotive oriented with either end thereof in the lead in the direction of travel of the locomotive, said method comprising the steps of:

providing at least two satellite signal receivers on the locomotive at spaced locations along the length of the locomotive;

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determining a set of phase differences between satellite reference signals received by satellite receivers; and

determining an accurate heading of the locomotive <u>during normal locomotive transit operation</u> using the set of phase differences between the satellite reference signals, <u>wherein the locomotive is self-propelled or propelled in a consist with other locomotives,</u> wherein the heading represents both the direction of travel of the locomotive and which end of the locomotive is in the lead in the direction of travel of the locomotive.

2. (previously presented) A method according to Claim 1 further comprising the step of determining a vector distance $\vec{\mathbf{d}}$ between two antennas mounted to the locomotive.

3. (previously presented) A method according to Claim 2 further comprising the step of determining $\vec{\mathbf{d}}$ as $\vec{\mathbf{d}} = (\mathbf{H}^T\mathbf{H})^{-1}\mathbf{H}^T\vec{\mathbf{y}}$, where:

$$\mathbf{H} = \begin{bmatrix} LOS_x^1 & LOS_y^1 & LOS_z^1 \\ LOS_x^2 & LOS_y^2 & LOS_z^2 \\ \vdots & \vdots & \vdots \\ LOS_x^n & LOS_y^n & LOS_z^n \end{bmatrix};$$

$$\vec{\mathbf{y}} = \begin{bmatrix} \Delta\phi^1 - \lambda(N_1^1 - N_2^1) - c(dt_1 - dt_2) \\ \Delta\phi^2 - \lambda(N_1^2 - N_2^2) - c(dt_1 - dt_2) \\ \vdots \\ \Delta\phi^n - \lambda(N_1^n - N_2^n) - c(dt_1 - dt_2) \end{bmatrix}; \text{ and}$$

$$\vec{\mathbf{d}} = \begin{bmatrix} d_x \\ d_y \\ d_z \end{bmatrix}$$, where ø represents a fractional phase part.

4. (previously presented) A method according to Claim 30 wherein said step of determining at least one of an accurate heading, heading rate, attitude, and attitude rate of the locomotive further comprises the step of determining an attitude and an attitude rate of a locomotive using $\vec{\mathbf{d}}$, the heading using $\tan^{-1}\frac{d_x}{d_y}$, and heading rate using $\frac{\tan^{-1} d_z}{\sqrt{d_x^2 + d_y^2}}$.

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5. (original) A method according to Claim 1 further comprising the step of determining a track curvature, *C*.

6. (original) A method according to Claim 5 wherein determining a track curvature comprises the step of detecting an angular rotation rate ω and a velocity v of the locomotive, wherein $C=\omega/v$.

7. (original) A method according to Claim 6 wherein detecting an angular rotation rate ω and a velocity v of the locomotive comprises the step of detecting an angular rotation rate ω using a gyroscope and a velocity v of the locomotive using a tachometer.

8. (original) A method according to Claim 6 wherein detecting an angular rotation rate ω and a velocity v of the locomotive comprises the step of detecting an angular rotation rate ω using received satellite signals and velocity v of the locomotive using a tachometer.

9. (original) A method according to Claim 5 wherein determining a track curvature comprises the step of determining a lateral acceleration a and a velocity v of the locomotive, wherein $C=a/v^2$.

10. (original) A method according to Claim 5 further comprising the step of controlling dispensing of a track lubricant in accordance with the determined curvature value *C*.

11. (original) A method according to Claim 10 wherein said step of controlling dispensing of a track lubricant further comprises the step of dispensing the lubricant when C exceeds a predetermined magnitude.

12. (original) A method according to Claim 1 further comprising the steps of:

determining a position of the locomotive; and

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accessing a database of track heading and grade to determine a present track heading and grade at the determined position of the locomotive.

13. (original) A method according to Claim 1 further comprising the steps of:

sampling latitude and longitude from the satellite receivers; and

determining a distance traveled by the locomotive.

14. (original) A method according to Claim 13 wherein said step of sampling latitude and longitude from the satellite receivers further comprises the steps of:

sampling where the distance between the samples is determined as $\Delta d = R[\Delta lat^2 + \cos^2(lat)\Delta long^2]^{1/2}$

where Δlat is a difference between latitudes of consecutive measurements;

$\Delta long$ is a difference between longitudes of consecutive measurements; and

R is the radius of the earth (about 3,440 nmi); and

said step of determining a distance traveled by the locomotive further comprises the step of summing Δd over successive measurements.

15. (currently amended) An apparatus for determining at least one of motion and location parameters of a railroad locomotive to detect curves and reduce track wear, with the locomotive oriented with either end of the locomotive in the lead in the direction of travel of the locomotive, said apparatus comprising:

at least two phase-locking satellite receivers configured to reference signals received from a set of satellites; and

a processor configured to determine a set of phase differences between the reference signals received by said satellite receivers and an accurate heading of the locomotive <u>during normal locomotive transit operation</u> using the set of phase differences between the reference signals, <u>wherein the locomotive is self-propelled or propelled in a consist with other locomotives</u>, wherein the heading represents both the direction of travel of the locomotive and which end of the locomotive is in the lead in the direction of travel of the locomotive.

16. (previously presented) A method according to Claim 15 further comprising the step of determining a vector distance $\vec{\mathbf{d}}$ between two antennas mounted to the locomotive

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17. (previously presented) An apparatus according to Claim 16 wherein said processor further configured to determine $\vec{\mathbf{d}}$ as $\vec{\mathbf{d}} = (\mathbf{H}^T\mathbf{H})^{-1}\mathbf{H}^T\vec{\mathbf{y}}$, where:

$$\mathbf{H} = \begin{bmatrix} LOS_x^1 & LOS_y^1 & LOS_z^1 \\ LOS_x^2 & LOS_y^2 & LOS_z^2 \\ \vdots & \vdots & \vdots \\ LOS_x^n & LOS_y^n & LOS_z^n \end{bmatrix};$$

$$\vec{\mathbf{y}} = \begin{bmatrix} \Delta\phi^1 - \lambda(N_1^1 - N_2^1) - c(dt_1 - dt_2) \\ \Delta\phi^2 - \lambda(N_1^2 - N_2^2) - c(dt_1 - dt_2) \\ \vdots \\ \Delta\phi^n - \lambda(N_1^n - N_2^n) - c(dt_1 - dt_2) \end{bmatrix}; \text{ and}$$

$$\vec{\mathbf{d}} = \begin{bmatrix} d_x \\ d_y \\ d_z \end{bmatrix}$$, where $\varnothing$ represents a fractional phase part.

18. (previously presented) An apparatus according to Claim 31 wherein said processor further configured to determine an attitude and an attitude rate of a locomotive using $\vec{\mathbf{d}}$, the heading using $\tan^{-1}\frac{d_x}{d_y}$, and the heading rate using $\frac{\tan^{-1} d_z}{\sqrt{d_x^2 + d_y^2}}$.

19. (original) An apparatus according to Claim 15 wherein said procdessor further configured to determine a track curvature, *C*.

20. (original) An apparatus according to Claim 19 wherein to determine a track curvature, said processor configured to detect an angular rotation rate ω and velocity v of the locomotive.

21. (original) An apparatus according to Claim 20 wherein to detect an angular rotation rate ω and velocity v of the locomotive, said processor configured to detect an angular rotation rate ω using received satellite signals and velocity v of the locomotive using a tachometer.

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22. (original) An apparatus according to Claim 20 wherein to detect an angular rotation rate ω and velocity v of the locomotive, said processor configured to detect an angular rotation rate ω using a gyroscope and velocity v of the locomotive using a tachometer.

23. (original) An apparatus according to Claim 19 wherein to determine a track curvature, said processor further configured to:

determine a lateral acceleration a and a velocity v of the locomotive; and

determine track curvature C as: $C=a/v^2$.

24. (original) An apparatus according to Claim 19 further comprising a device for dispensing a lubricant to a track.

25. (original) An apparatus according to Claim 24 wherein said processor further configured to control said device dispensing the lubricant in accordance with the determined curvature value *C*.

26. (original) An apparatus according to Claim 25 wherein said processor further configured to dispense the lubricant when *C* exceeds a predetermine magnitude.

27. (original) An apparatus according to Claim 24 wherein said processor further configured to:

determine a position of the locomotive;

access a database of track heading and grade to determine a present track heading and grade at the determined position of the locomotive; and

control said device dispensing lubricant in accordance with a curvature value *C* contained within the track database.

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28. (original) An apparatus according to Claim 15 wherein said processor further configured to:

sample latitude and longitude from the GPS receivers; and

determine a distance traveled by the locomotive.

29. (original) An apparatus according to Claim 28 wherein said processor configured to determine a distance between samples as:

$$\Delta d = R[\Delta lat^2 + \cos^2(lat)\Delta long^2]^{1/2}.$$

30. (previously presented) A method in accordance with Claim 3, wherein said step of determining an accurate heading of the locomotive using the set of phase differences between the satellite reference signals further comprises determining at least one of an accurate heading rate, attitude, and attitude rate of the locomotive using the set of phase differences between the satellite reference signals.

31. (previously presented) An apparatus in accordance with Claim 17, wherein said processor further configured to determine at least one of an accurate heading rate, attitude, and attitude rate of the locomotive using the set of phase differences between the satellite reference signals.